2012 North Idaho Douglas-fir Tussock Moth Pheromone Trapping Report

Report No. IDL 12-2
January 2013

2012 NORTH IDAHO DOUGLAS-FIR TUSSOCK MOTH TRAPPING SYSTEM REPORT

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Introduction

Idaho's Douglas-fir tussock moth (DFTM) Early Warning System (EWS) uses a series of permanent pheromone trap sites to identify increasing populations prior to undesirable tree defoliation, a system modified after Daterman et al. (1979). This pheromone trapping is designed to detect population changes over large geographic areas, and to give land managers advance warning of an impending outbreak.

The Idaho Department of Lands (IDL) maintains a network of trap sites from Coeur d'Alene south to Moscow and east to Harvard (Figure 1), with additional trap sites maintained by the United States Forest Service. Personnel from Forest Health Protection, Coeur d'Alene Field Office, (USFS-R1) maintain trap sites from Potlatch to Lucille (Figure 2), while Forest Health Protection personnel from the Boise Field Office, (USFS-R4) monitor trap sites in southern Idaho (Figure 3).

To monitor the flight of male moths, five pheromone-baited sticky traps are installed at each site in a transect with a minimum spacing of 75 feet between traps. Traps are placed in young, open-grown host trees (grand fir or Douglas-fir) in late July to early August and are collected in October. An average trap catch of 25 moths per trap at a site is the threshold normally used to indicate where defoliation may occur in following years. Follow up sampling is then conducted

in these areas to pinpoint injurious population densities (Daterman et al. 1979) and to apply treatments, if necessary. Egg mass sampling is conducted in the fall, and larval sampling is conducted in the spring of the following year at sites where trap counts reach the threshold. Larval sampling may also be conducted at sites with historic tussock moth problems before trap counts reach an average of 25 per trap.

2012 Trapping Results

A total of 176 sites were monitored in northern Idaho (141 by IDL and 35 by USFS-R1), and 9 sites were monitored in southern Idaho (USFS-R4) during 2012. The overall mean trap capture for the IDL traps in 2012 was 6.3 moths per trap, compared to 43.8 and 11.8 moths per trap in 2011 and 2010, respectively (Figure 4, Appendix 1.). The 2012 average trap capture for the USFS-R1 traps was 0.24 moths per trap compared to 7.6 and 1.1 moths per trap in 2011 and 2010, respectively (Appendix 2). The 2012 USFS-R4 average was 0.8 compared to 1.5 moths per trap in 2011 (Appendix 3). Average trap captures at IDL sites dropped dramatically in 2012, indicating the collapse of the outbreak in northern Idaho. In 2012, 11 trap sites in northern Idaho had trap captures ≥ 25 moths per trap and only 2 sites where the average exceeded 50 per trap. In 2011, 110 sites had trap captures ≥ 25 per trap and 59 sites exceeded an average of 50 per trap. When the trap averages are examined by the three main areas of past outbreaks (Moscow Mountain, McCroskey State Park, and Coeur d'Alene Indian Reservation), all areas had a dramatic decrease in trap site averages. The trap sites in McCroskey Park decreased the least, from an average of 55.1 in 2011 to 24.6 in 2012. The Coeur d'Alene Indian Reservation and the Moscow Mountain area averages decreased from 55.1 and 44.0 in 2011 to 8.8 and 3.1 in 2012, respectively. These area averages were obtained from trap sites that have been in place for the longest time (going back to 1977). Additional traps were placed in all three areas during the 1986, 2001 and current outbreaks.

Defoliation

Prior to 2010, the most recent outbreak in northern Idaho started in 2000, and resulted in three years of defoliation on State and private lands between Plummer and Moscow and in adjacent Clearwater National Forest lands (Figure 5.). The bulk of the defoliation occurred in Latah County and McCroskey State Park, with some defoliation reaching as far north as Plummer. Outbreaks of DFTM have occurred in this general area approximately every 8-10 years since the 1940's. Prior to the 2000 outbreak, aerially visible defoliation occurred for one year during 1986. Both outbreaks were preceded by increasing numbers of trap captures (Randall 2002) (Figure 4.), and the trap averages were over 40 per trap in the year before defoliation was observed. In 2010, over 8,500 acres of defoliation was visible by aerial survey in both Kootenai and Benewah Counties. The defoliated acres increased in 2011 to over 68,500 in Kootenai, Benewah, and Latah Counties. Defoliation was centered much further north than during previous outbreaks, with only limited defoliation occurring near Moscow Mountain. Most of the defoliation was in Kootenai County near Signal Point, in Benewah County near Plummer, and in McCroskey State Park. Approximately 31,000 acres of defoliation was observed via aerial survey in 2012, most of this occurring in the Benewah Creek and McCroskey State Park areas (Figure 6). There was very little defoliation observed in the Moscow Mountain area in 2012.

Over 40,000 acres of defoliation was recorded in the Nez Perce National Forest south and east of Grangeville in 2011, but this defoliation decreased to approximately 3,800 acres in 2012 (Figure 7). Prior to the current outbreak, significant defoliation had not been observed in

either Kootenai County or the Nez Perce National Forest since 1974 (Tunnock 1985). Ornamental spruce and grand fir trees have been damaged by DFTM in the Coeur d'Alene area since at least 2007. Damage to ornamentals is common before outbreaks develop in the forest (Sturdevant 2000, Tunnock 1985). Defoliation of spruce was observed at the USFS Coeur d'Alene nursery in 2007 and 2008, and grand fir yard trees were defoliated at Twin Lakes and Mica Flats in 2009 and 2010.

Larval Surveys

IDL normally conducts sequential larval sampling using a threshold less than 25 moths per trap. Trap sites where trap catches have increased, or historical trouble spots are usually sampled for larvae the following year, regardless of the actual trap count. A DFTM suppression project was conducted on private lands which required intensive larval sampling on participating properties to determine optimal insecticide application timing. In 2012 larval surveys were not performed outside the scope of the suppression project. Sequential surveys are most useful before widespread defoliation occurs, and are of limited use during an outbreak (Mason 1979).

Egg Mass Sampling

Egg mass sampling gives the best indication of the populations and potential for defoliation in the following year. Sampling was conducted at 125 sites in 2012, compared to 282 sites in 2011. Sampling was concentrated near trap sites that had high trap numbers or where defoliation was observed in 2012. Egg masses were found at only two of the 125 sites (Figure 8). These results indicate that the DFTM population collapsed due to natural controls. By comparison, egg masses were found at 127 of 282 sites in 2011. Sampling was conducted by examining grand fir and Douglas-fir trees for ten minutes, and counting the number of egg masses observed. Sampling sites were selected in defoliated areas and outward to delimit the area of infestation. One plot was sampled in each section (640 acres) where host material was present and road access was available. This was the method used by IDL during the previous outbreak (2000-2002).

Virus and Parasite Assay

An assay to determine the level of nuclear polyhedrosis virus (NPV) was performed in early 2012. Egg mass samples were collected during the egg mass survey in 2011, and given to Dr. Stephen Cook, Professor of Entomology at the University of Idaho. Viral incidence ranged from zero at six of the 23 sites, to a high of 45% at the Windfall Pass collection site (Appendix 4). Viral–caused mortality at four of the sites was above 25% (Figure 9), which is considered enough to cause collapse of the larval population (at a given site) before defoliation is visible (Stelzer 1979). Overall mortality at all sites was high as well (40%), and may indicate an unhealthy moth population, or may be due to experimental error, such as feeding on artificial diet. Overall incidence of parasitism was generally high (average of 61%), except for two sites that showed no parasitism (Appendix 5). The most numerous parasitoid species was *Telenomus californicus*, which is a very common parasite of DFTM larvae (Torgersen 1977).

Summary of 2012 Suppression Project

Since the 2011 egg mass survey indicated that there would be an overwintering population, plans were made in late 2011 to proceed with a suppression effort on private lands if there was sufficient interest among landowners in the affected area. A public outreach effort using press releases and public meetings was begun in early 2012 to inform landowners about the development of the outbreak and the status of the viral assay. A consultant was contracted to coordinate landowners interested in participating in a coordinated suppression effort. IDL established monitoring plots on participating properties to determine the optimum time to spray. Plots were established in May before egg hatch, and were monitored until approximately 60% of larvae had reached the 2nd instar. On June 29th, 14 properties totaling 616 acres were sprayed with Mimic 2LV, an insect growth regulator (Figure 10). The larval populations after treatment averaged 92.1% lower than the prespray counts. The overall reduction on untreated plots was 66.5%, indicating that the virus and other natural controls were impacting larval populations. Larval populations were high enough to treat and defoliation did occur in adjacent untreated areas, indicating that foliage was protected on treated properties.

Conclusions

The DFTM-EWS has been generally effective at predicting outbreaks in northern Idaho. The two previous outbreaks were preceded by several years of increasing trap catches. However, the intensity of the outbreaks was not predicted by trapping alone. Trap catches preceding defoliation in 1986 were similar to trap captures prior to the 2000 outbreak; yet the intensity of the two outbreaks was very different. The outbreak in 1986 caused detectable defoliation for one year, while defoliation in the 2000 outbreak was evident for three years. The current outbreak is different for a couple reasons; the overall average trap catch did not increase from 2009 to 2010, and defoliation was observed in unexpected areas. The average trap count actually declined slightly in 2010 (11.77) compared to 2009 (11.86). In 2011, the average trap count increased to 43.8, a level that would be expected the year prior to observed defoliation. Defoliation peaked in 2011, covering 68,500 acres, then declined to 31,000 acres of defoliation and an average trap catch of 6.3 in 2012. This confirms the need for additional population sampling, such as egg mass and larval sampling to help determine the intensity of outbreaks (Mason and Torgersen 1983, Kegley et al. 2004).

The egg mass survey conducted in the fall of 2012 indicated that the outbreak collapsed in the Palouse region. Only two egg masses were detected in the survey of 125 defoliated locations, compared to over 1100 egg masses at 282 sites during the 2011 survey. If the DFTM populations behave according to past trends, increasing populations can be expected to increase again in this area in approximately six to eight years..

The DFTM-EWS **is not designed nor is it intended** to predict the exact location of future defoliation. Follow-up sampling is conducted in areas that are selected based on historical experience and the potential impact of DFTM defoliation on management objectives. The defoliation observed in 2010 was not preceded by increasingly higher average trap captures as in the two previous outbreaks; in fact the trap averages did not reach the historic high levels until fall 2011 (the second year of defoliation). The unusual nature of the current outbreak illustrates the importance of an integrated sampling plan utilizing pheromone traps, supplemental sampling (larval and egg mass), as well as aerial detection. Characterizing the

full extent of the defoliation would have been difficult without an aerial survey, because defoliation occurred in areas that had not experienced outbreaks in the recent past.

Literature Cited

Daterman, G.E., R.L. Livingston, J.M. Wenz, and L.L. Sower. 1979. Douglas-fir tussock moth handbook. How to use pheromone traps to determine outbreak potential. USDA Agriculture Handbook No. 546. 11 p.

Kegley, S.J., D. Beckman, and D.S. Wulff. 2004. 2003 North Idaho Douglas-fir tussock moth trapping system report. USDA Forest Service, Northern Region, Forest Health Protection Rpt. 04-6. 7 p. (Link)

Mason, R.R. 1979. How to sample Douglas-fir tussock moth larvae. USDA Agriculture Handbook 547. 15 p.

Mason, R.R. and T.R. Torgersen. 1983. Douglas-fir tussock moth handbook. How to predict population trends. USDA Agriculture Handbook No. 610. 7 p.

Randall, C. 2002. Douglas-fir tussock moth biological evaluation, Palouse Ranger District, Clearwater National Forest, 2001. USDA Forest Service, Northern Region, Forest Health Protection Rpt. 02-5. 33 p. (Link)

Stelzer, M.J. 1979. Douglas-fir tussock moth handbook. How to determine the occurrence of virus in egg masses. USDA Agriculture Handbook No. 548. 7 p.

Sturdevant, N. 2000. Douglas-fir tussock moth in northern Idaho and western Montana, current activity and historical patterns. USDA Forest Service, Northern Region, Forest Health Protection Rpt. 00-12. 6 p. (Link)

Torgersen, T.R. 1977. Identification of parasites of the Douglas-fir tussock moth, based on adults, cocoons, and puparia. USDA-Forest Service Research Paper PNW-215. 28 p.

Tunnock, S., M. Ollieu, and R. W. Thier, 1985. History of Douglas-fir tussock moth and related suppression efforts in the Intermountain and Northern Rocky Mountain Regions 1927 through 1984. USDA Forest Service Intermountain and Northern Regions. Rpt. 85-13. 51 p. (Link-*Very large file*)

Figures.

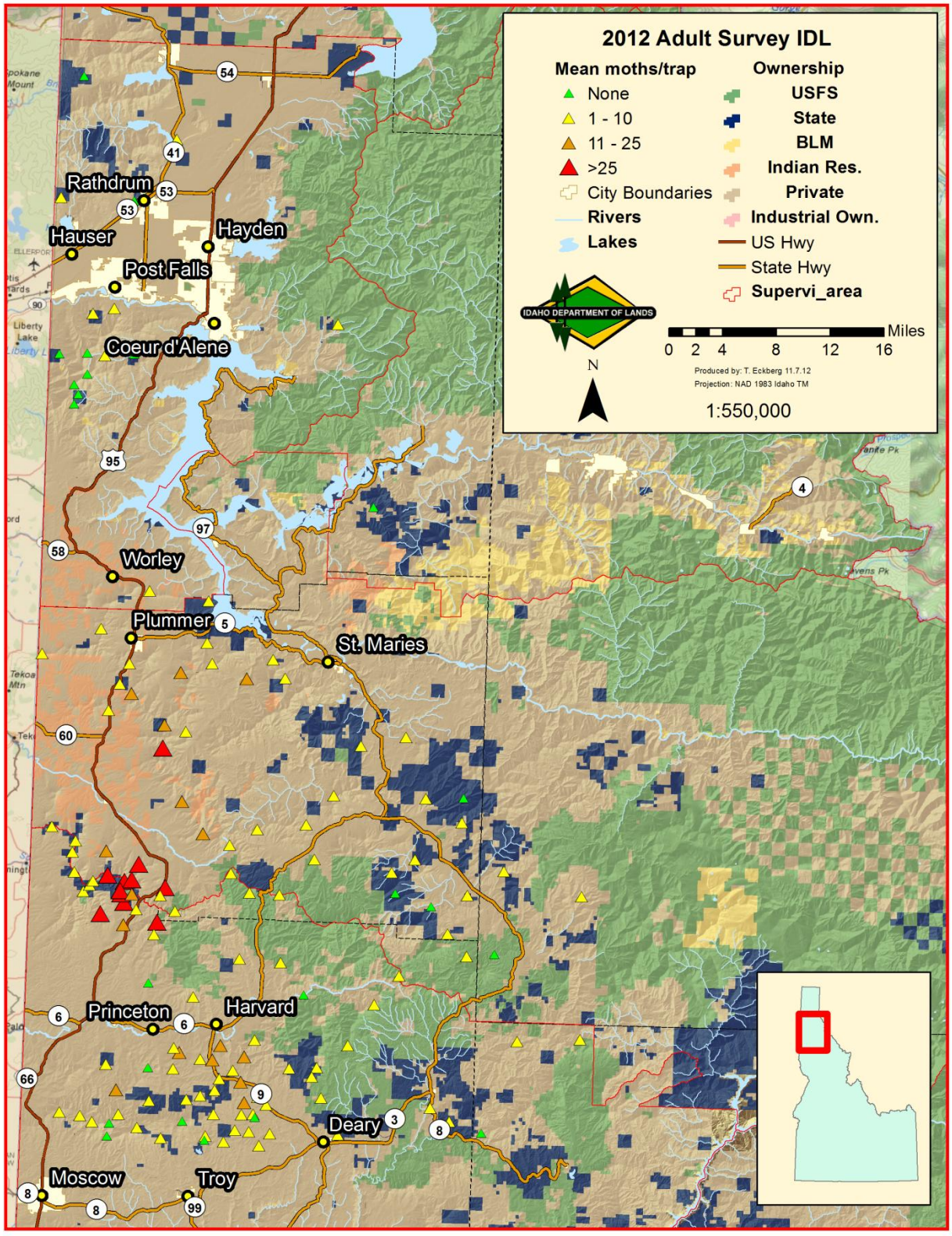

Figure 1. Map of plots trapped by IDL for Douglas-fir tussock moth in 2012.

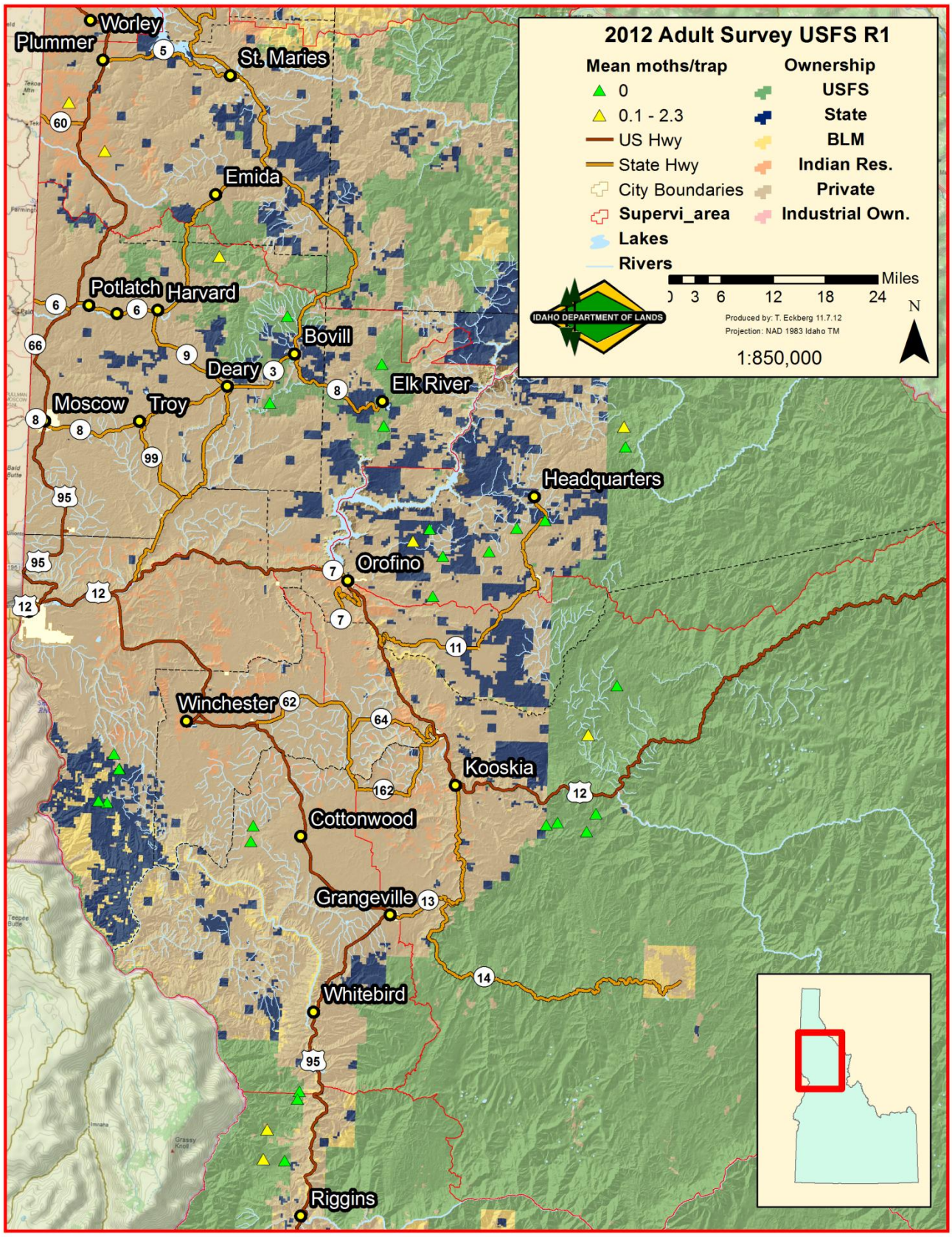

Figure 2. Map of plots trapped by USFS Region 1 for Douglas-fir tussock moth in 2012.

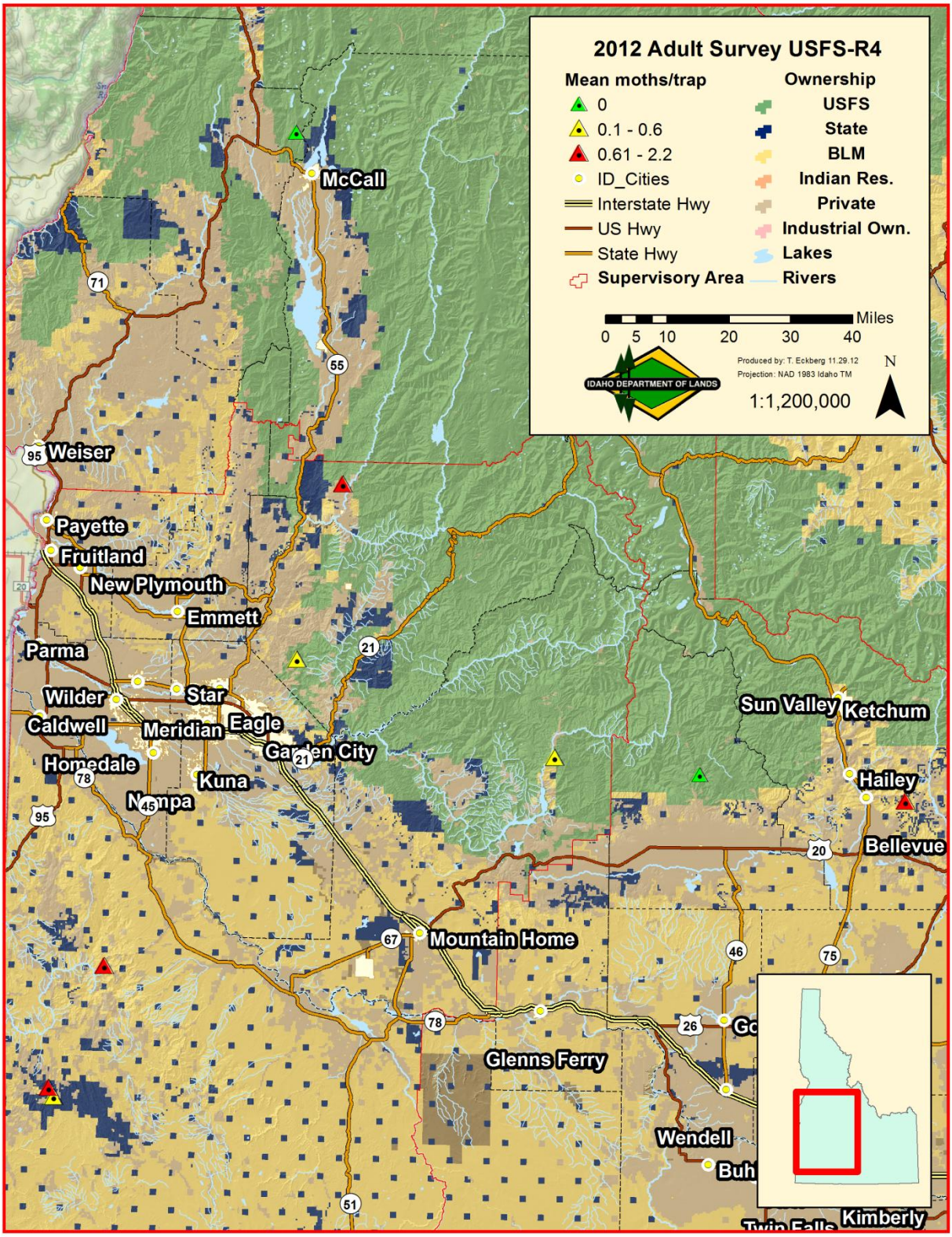

Figure 3. Map of plots trapped by USFS Region 4 for Douglas-fir tussock moth in 2012.

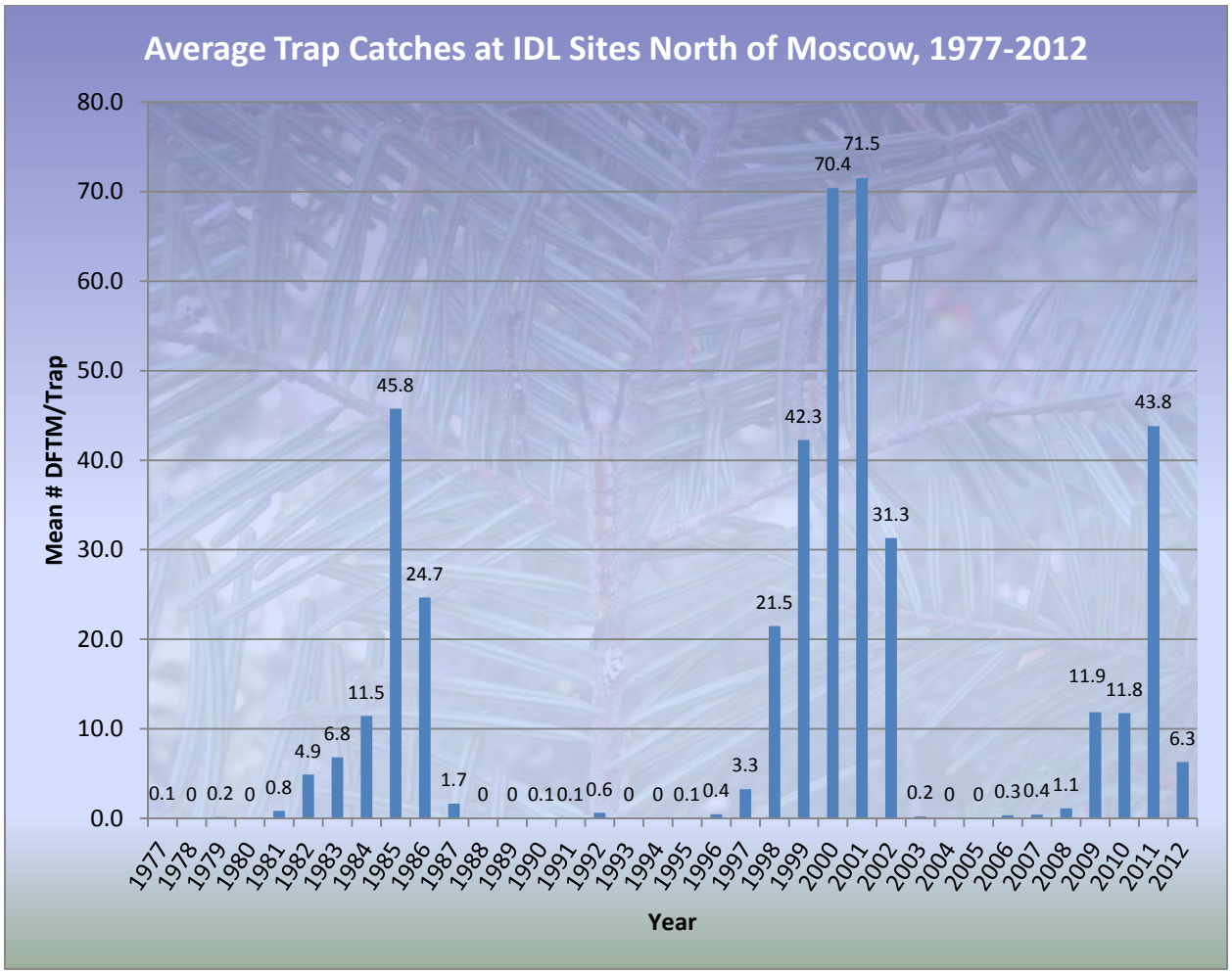

Figure 4. Mean trap catches of Douglas-fir tussock moth by IDL for plots north of Moscow from 1977 through 2012.

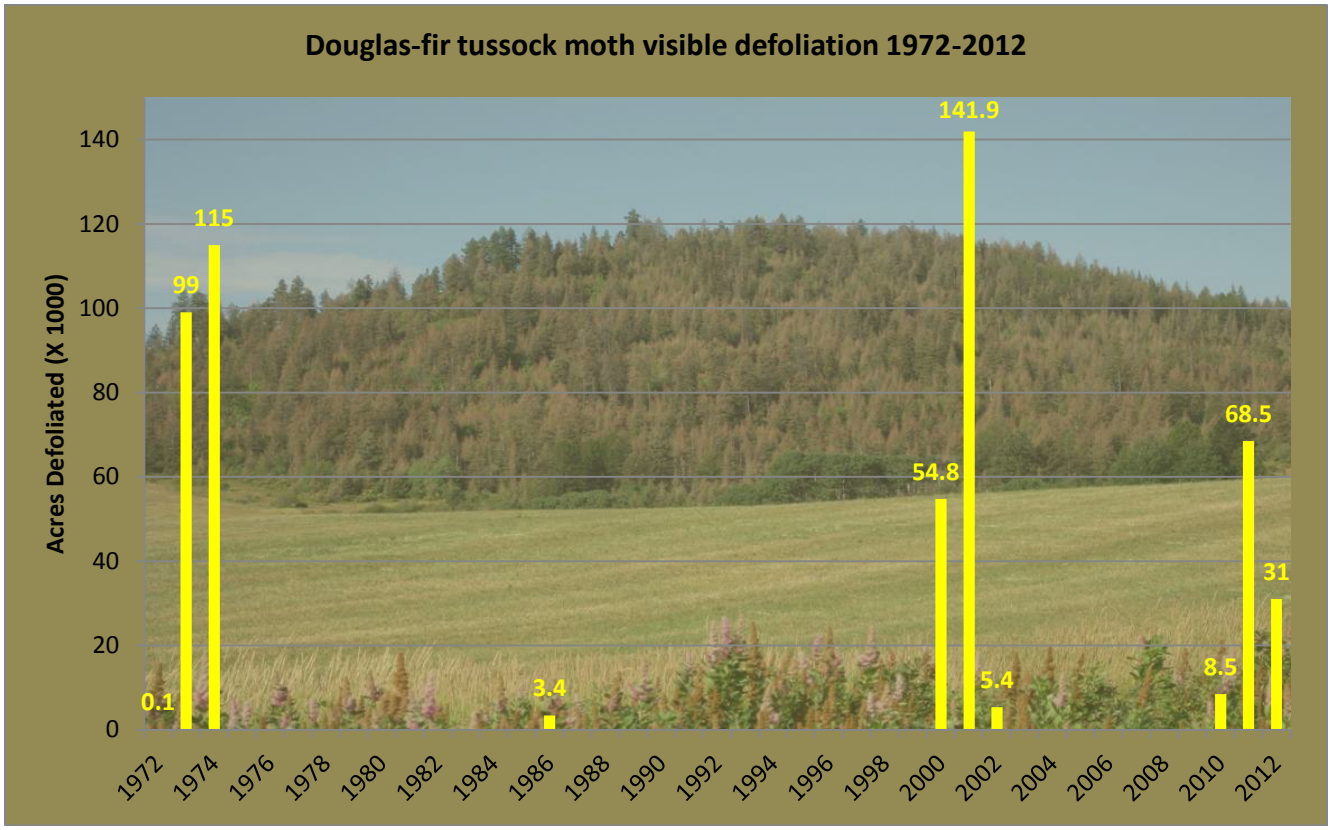

Figure 5. Aerially detected defoliation in northern Idaho since 1972.

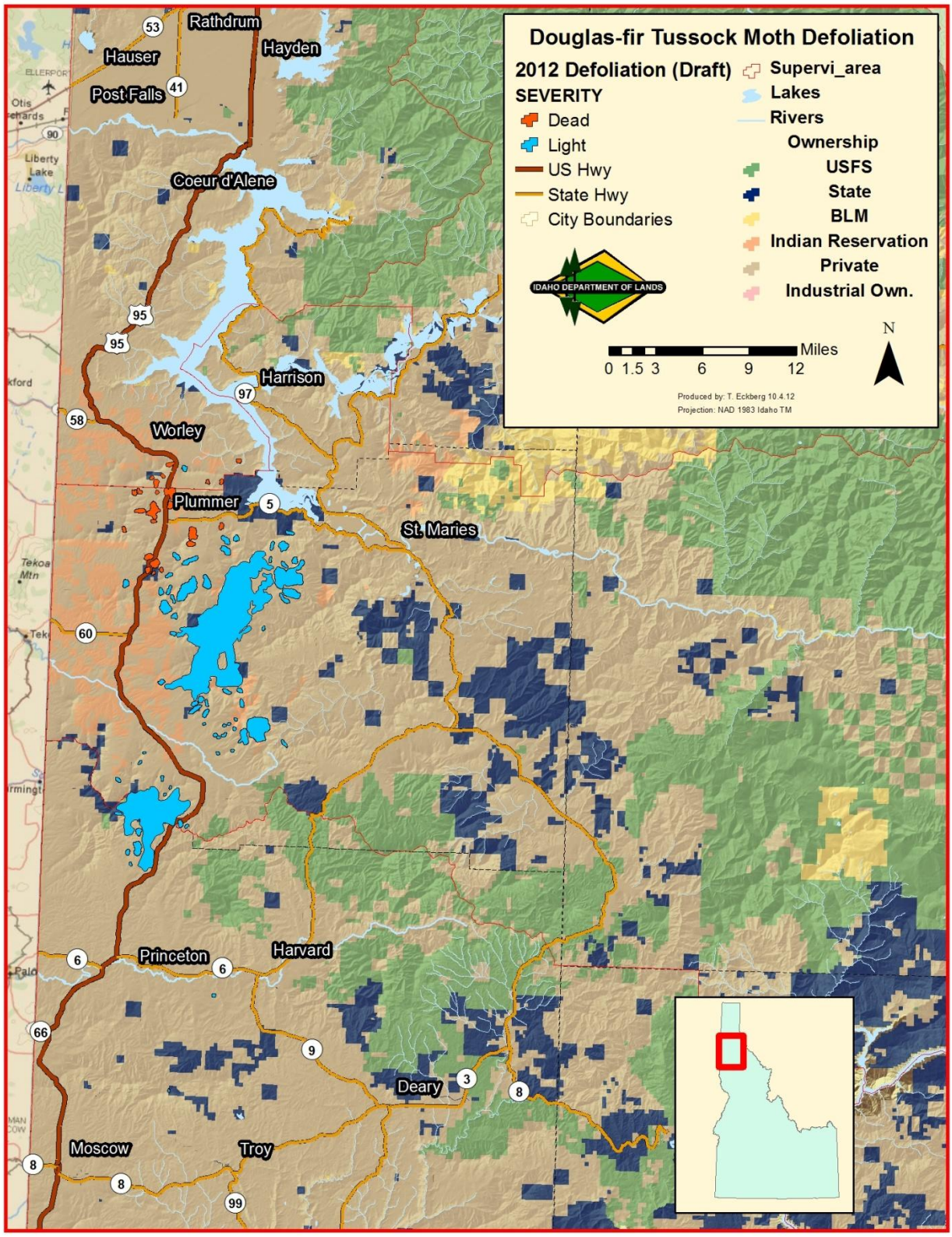

Figure 6. Douglas-fir tussock moth defoliation visible via aerial survey in north Idaho in 2012.

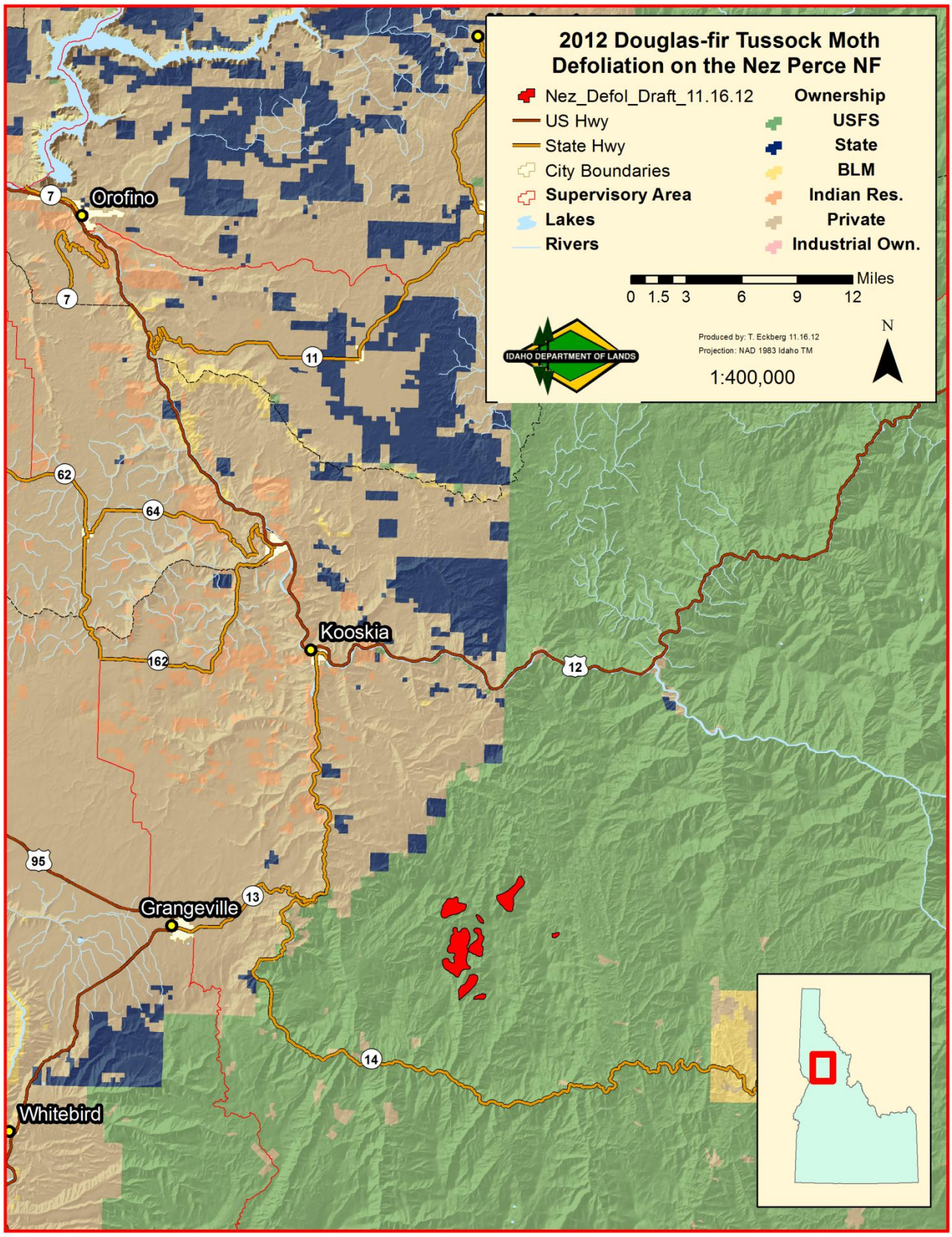

Figure 7. Douglas-fir tussock moth defoliation on the Nez Perce National Forest in 2012.

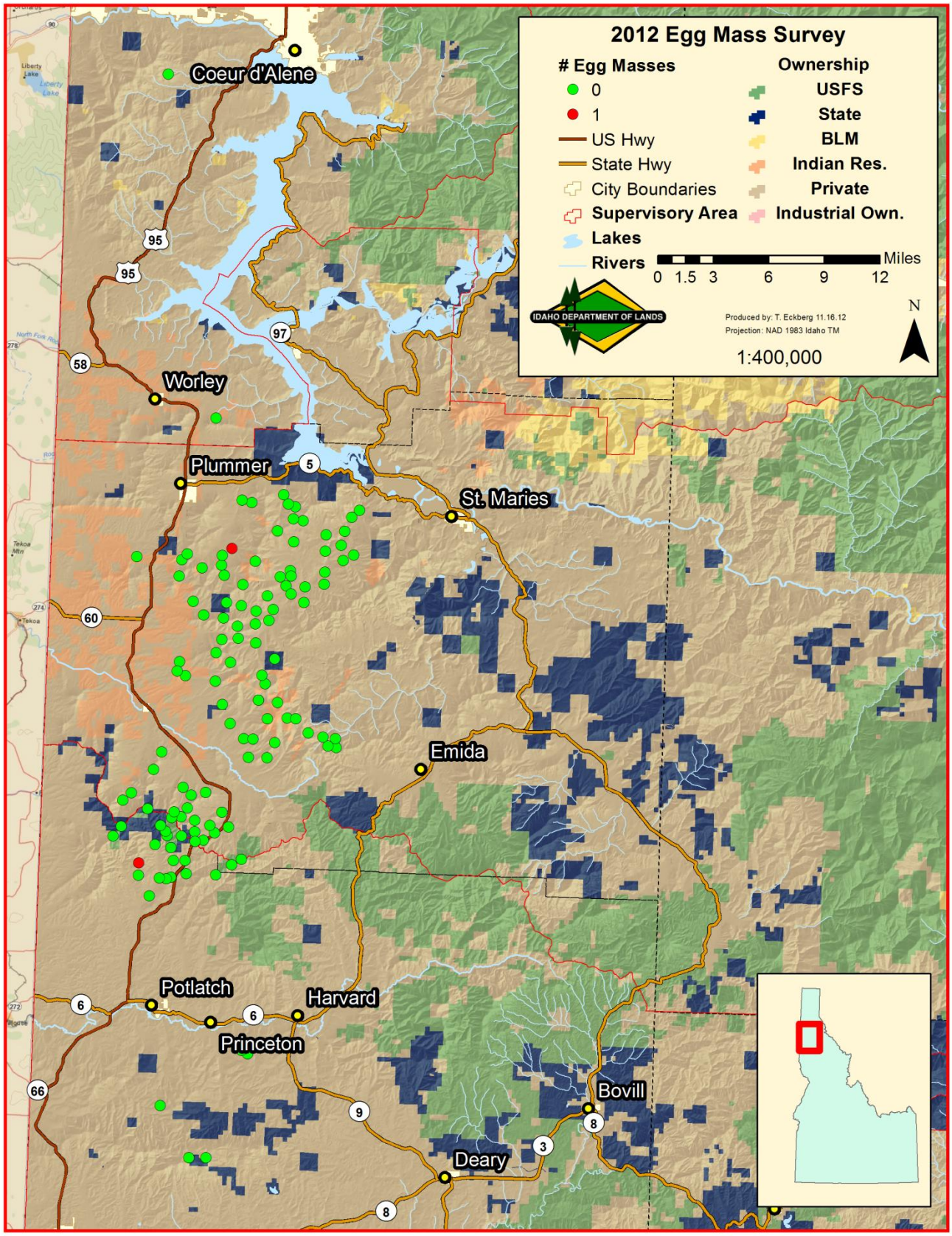

Figure 8. Sites sampled for Douglas-fir tussock moth egg masses by IDL in 2012.

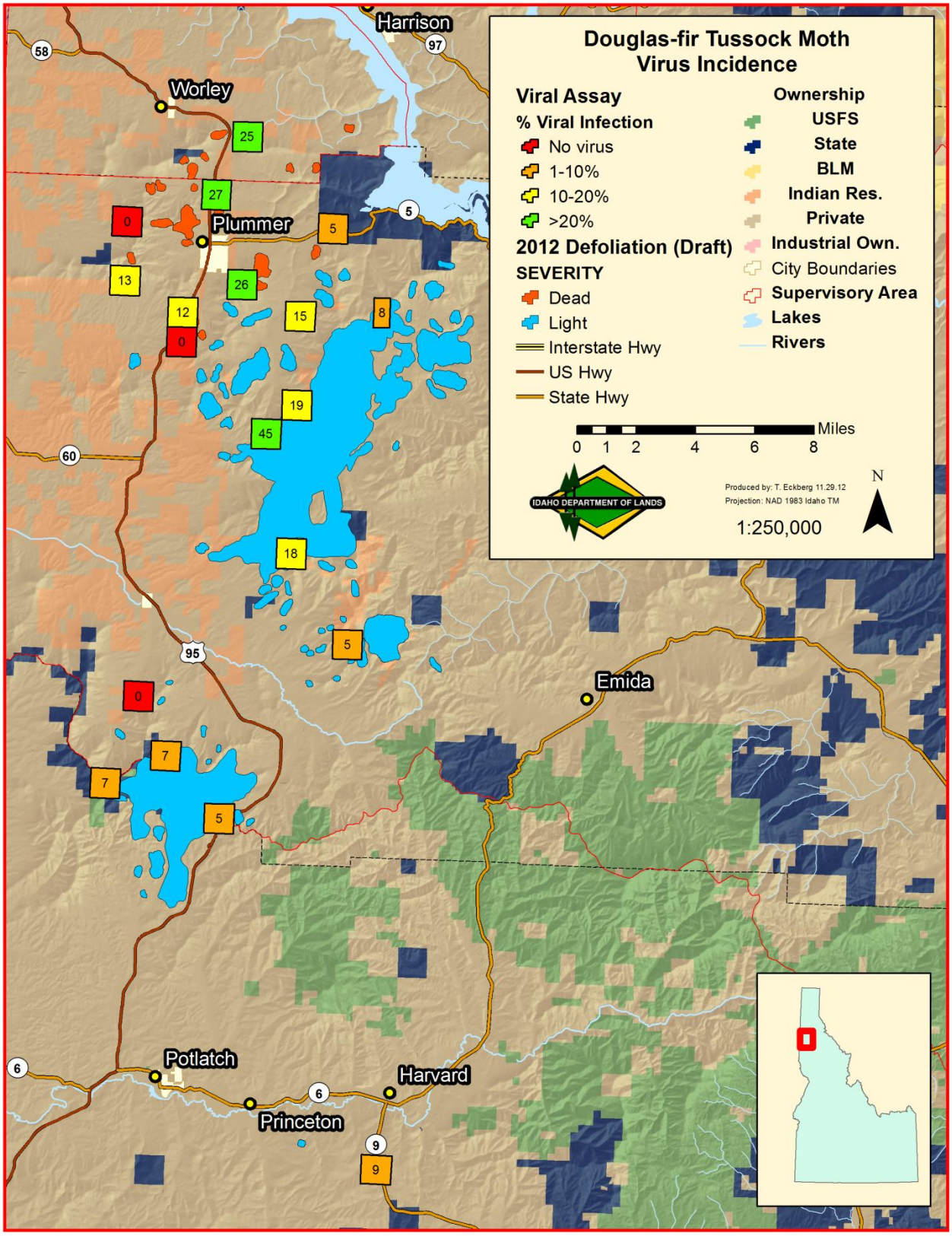

Figure 9. Incidence of nuclear polyhedrosis virus from egg mass samples collected in fall 2011. Numbers inside the boxes represent the percent mortality of larvae killed by virus as determined from an assay conducted by the University of Idaho.

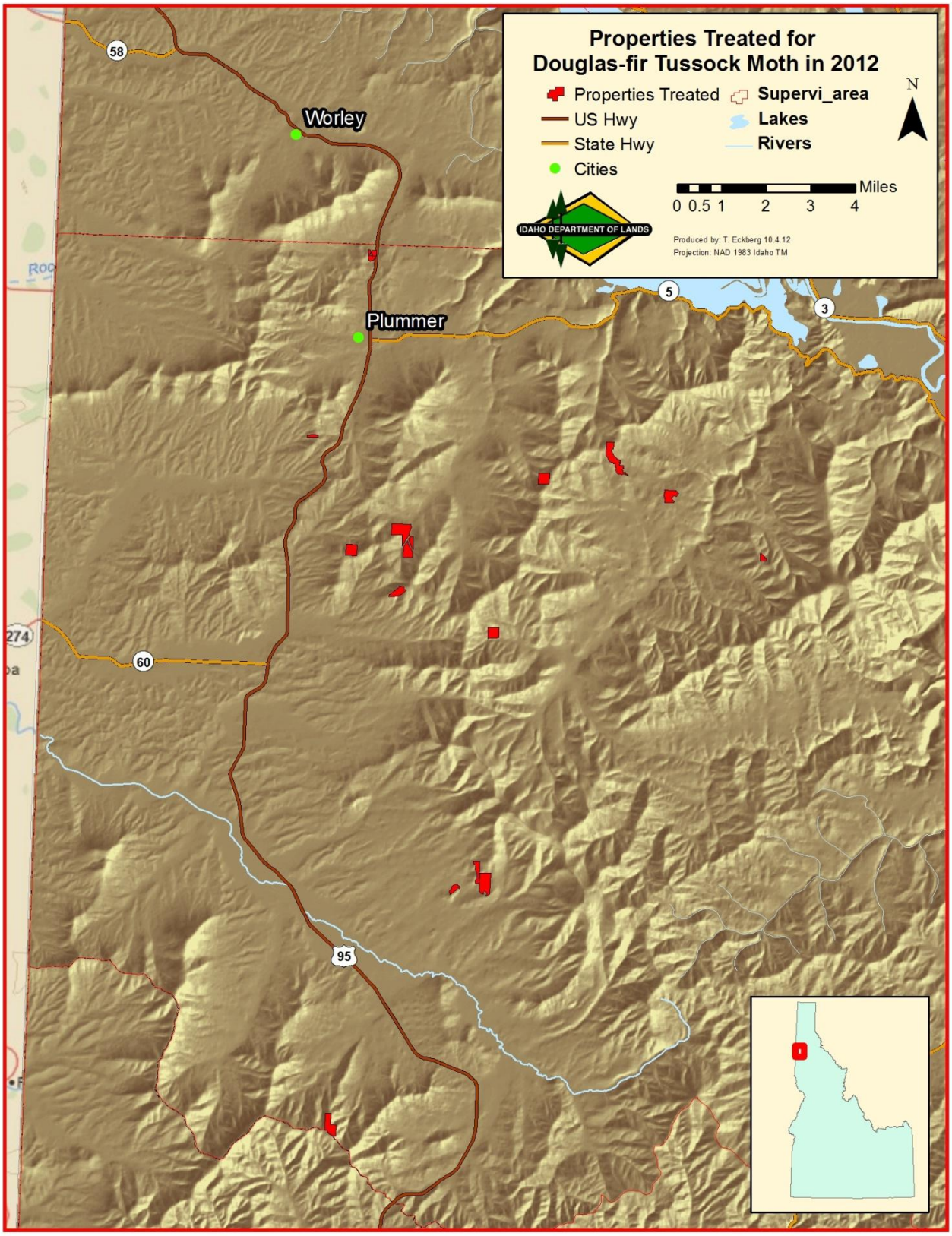

Figure 10. Properties treated for Douglas-fir tussock moth in 2012.

Appendix 1. Mean trap catch for IDL monitored plots from Coeur d'Alene to Moscow for the past 12 years.

IDL 2001 - 2012 Douglas-fir Tussock Moth Trap Results

Mean Number of Moths Per Trap

Plot #	Area	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
3	Lolo Pass	26.8	*30.2*‡	*26.4*‡	5.2	0.4	0‡	0	0	0	0	8.2	110.2
4	Charles Butte	0.4	*81.4*‡	*32.2*‡	5.4	0	0‡	0	0	0	0.2	28.2	84.8
5	Peterson Point	2.4	*52.8*‡	8.6	2.2	0	0‡	*	0	0	0.2	15.8	101.0
6	East Dennis	0.2	*33.2*	2.3‡	9.0	0.2	0.2‡	0	0	0	1.2	75	101.2
7	East Gold Hill	3.0	*38.0*	2.0	3.4‡	0.8	0‡	0	0	0	0.2	14.8	53.8
8	Flat Creek	0.2	*48.0*	8.0	1.0	0.2	0‡	0.4	0	0.2	0	7.6	88.0
9	Long Creek	5.0	*56.2*‡	10.2‡	*20.6*‡	3.4‡	3‡	0.2	0	0.2	0.2	33.6	0.2
10	Paradise Point	0.2	*44.6*	9.8	2.0‡	1.2	0.2‡	0.2	0	0.2	0	17	91.8
11	Mineral Mountain	22.2	*11.6*‡	10.8‡	*25.0*‡	4.2‡	0.5‡	0	0	0	1.8	75.2	56.4
12	Mission Mountain	5.0	*66.4*‡	8.0‡	*20.8*	0.6	0.2‡	1.2	0	1.2	0.2	25.6	1.6
13	Spring Valley Creek	0	6.2	1.0	0.6	0	0‡	*	0	0	0	5.4	58.0
14	Vassar Meadows	1.0	*53.6*‡	17.0‡	12.8	0‡	0.4‡	0	0	0	0	95.8	102.8
15	Fairview Knob	8.2	*86.4*	6.6‡	9.2‡	0.8‡	0.4‡	0	0	0	0.2	39	105.8
21	West Twin (10-115)	0.4	*55.0*‡	4.0‡	5.3‡	1.2‡	0.4	*	0	0	0	8.8	75.4
22	Moscow Mtn (115-114)	*0.2*	17.0	0.0	3.6	0	0	0	0	0	0.2	5.8	78.0
101	Benewah	1.0	*51.4*‡	16.4‡	5.0	0	0.2‡	1.4	0	1.4	2.8	52.2	92.4
102	Windfall Pass	10.4	*83.0*‡	*29.4*‡	*32.0*‡	12.5‡	0.75‡	0.6	0	0.6	0.6	40.4	99.6
103	Squaw Creek	23.6	*41.0*	2.6	1.8	0	0	*	0	0	0.2	9.4	89.2
104	Moses Mountain	10.2	*51.8*‡	7.5	3.4	0.2	0	0	0	0	0.2	6.4	67.8
105	Little John Creek	1.6	*51.2*	0.0	2.2	0‡	0.6	0	0	0	1.4	45	78.4
106	Emida Peak	2.5	*65.8*	1.4	1.6	0‡	0.4	0	0	0.2	2.6	64.2	75.8
107	North-South Ski Area	1.4	*74.8*	2.3	m	0	0	0	0	0	0.6	83.2	107.2
108	Bald Mountain	*	*	*	*	*	*	*	0	0	0	25.2	53.8
109	Laird Park	0.2	*42.0*	1.4	2.2	m	0	0	0	0	1	66	86.0
110	North Fork Palouse River	0	12.0	0.0	0.4	0	0	0	0	0	1	83.2	75.2
111	Mica Mountain	3.2	*63.2*	16.6‡	20.8	0.2	0.2	0	0	0	0.2	67.6	93.6
112	Schwartz Creek	2.6	*59.4*	16.2‡	7.0	0.4	0	0	0	0	0.2	80.6	110.6
113	Big Bear Creek	3	*39.8*‡	15.2‡	11.6‡	1.8‡	0.6‡	0.6	0	0.6	0.2	47.8	87.0
114	Big Meadow Creek	0.2	*41.5*	0.8‡	0.4	0	0‡	0.2	0	0.2	0	11.2	70.2
115	East Twin Mountain	0	*66.8*	6.8	5.4‡	1.2‡	0.4‡	0.2	0	0.2	0	7.6	85.4
116	Crane Point	*3.8*	*43.0*	6.8	0	0.2	0	*	0	0	0	51	89.0
117	Sheep Creek	1.8	*50.8*‡	*21.0*‡	*20.8*‡	2.0	0‡	0.2	0	0.2	0	27.8	83.2
118	West Fork Mission Creek	1.8	*64.2*	7.0‡	6.8‡	1.4	0.2	*	0	0	0	22.2	47.6
119	1 Mi N. of Mineral Mtn	*43.6*	*61.6*‡	*24.6*	2.2	0.2	0	*	0	0	0	25.2	0.2
200	2 mi W of Plummer	4.8	*28.8*‡	7.0‡	*34.2*‡	2.2‡	2.6	*	0	0	0	16.2	80.2
201	Coon Creek	9.8	*97.4*‡	18.0‡	21.8‡	1.8‡	3‡	2	0	0.4	0.2	21.6	93.8
202	3 mi E of Benewah	*	*	*	*	*	*‡	0.2	0	0.2	0.6	21	102.2
203	Benewah Point	0.6	*47.0*	8.4	3.4	0‡	0.4	*	0	0	0	8.2	92.4
204	John's Point	*	*	*	*	*	*	*	0	0	0	23.8	*
205	3 mi E of Charles Butte	2.2	*52.4*	6.5	2.0	0‡	0.8‡	0	0.2	0.2	0.4	63.6	72.6
206	Sunset Mountain	*	*	*	*	*	*	*	0	0	0	20.8	*
207	West Fork Emerald Creek	0.2	*4.6*	0.0	0.4	0.2	0	*	0	0	0	23.2	*
208	Cedar Butte	0	*41.4*	1.4	0.4	0	0	*	0	0	0	22.4	76.2
209	Abes Knob	0.2	*54.4*	5.6	2.4	0.2	0.2	*	0	0	0	23.8	88.4

* Indicates Sites Not Trapped m indicates traps missing ‡ Indicates larval survey *Italics indicates egg mass sample*

Appendix 1. (continued)

IDL 2001 - 2012 Douglas-fir Tussock Moth Trap Results

Mean Number of Moths Per Trap

Plot #	Area	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
210	West Fork Deep Creek	*37.8*	*83.2*‡	*29.6*	4.6	0	0.2‡	0.2	0	0.2	0.2	77	90.6
211	Cherry Butte	0.2	*55.4*	2.8	0.6	0	0‡	0	0	0.2	0.4	67.2	88.6
212	Jackson Mountain	0	*15.4*	1.6	1.0‡	1.0	0.2	*	0	0	0	19.6	*
216	1 mi NW of Mineral Mtn	*47.4*	*70.6*‡	*27.6*‡	*32.4*‡	0.8	0‡	0.4	0	0.4	0.2	1	0.2
217	Head of Sheep Creek	*33.4*	*38.4*‡	*8.8*‡	*36.8*‡	7.8	0‡	0.2	0	0.2	0.6	21.2	97.2
300	Mission Mountain (#2)	4.0	*38.8*‡	13.8‡	*22.4*‡	2.2	0	0.4	0	0.4	0.6	6.4	67.0
301	1.5 mi S of Mineral Mtn	*81.0*	*66.6*‡	*62.8*‡	37.6‡	2.4	0‡	0.2	0	0.2	0.2	69.4	91.2
302	Middle Fork of Deep Creek 1	*75.8*	*61.6*‡	48.6‡	*38.0*‡	3.6‡	1	*	0	0	0	63.8	3.6
303	Middle Fork of Deep Creek 2	*33.8*	*71.6*‡	*27.2*‡	*33.0*‡	1.6	0.2	0.4	0	0.2	1	58	15.8
400	3 mi S of Mineral Mtn	*28.0*	*42.8*‡	*23.8*	1.0	0‡	0.6‡	0.2	0	0.2	0.6	75.8	86.6
401	Flynn Butte	1.2	*41.6*	3.4	0.6	0	0	0	0	0	3.2	95.2	96.4
402	2 mi SE of Browns Mdw	2	*43.2*	3.0	4.8	0	0.2‡	0.2	0	0.2	0	15.2	57.4
500	3 mi SW of Harvard	1.4	*45.0*‡	13.4	1.0	0	0‡	0.2	0	0.2	0	18.8	74.6
501	3 mi S of Moon Hill	0.2	*48.6*	*1.4*	1.0	0	0	*	0	0	0	16.2	97.6
502	3 mi W of Crane Point	1.4	*71.8*‡	15.2‡	6.2	0	0.2	*	0	0	0.6	67.6	75.0
503	3 mi N of Stanford Point	13.0	*50.0*‡	17.5‡	17.6‡	1.0‡	1	*	0	0	0	10.2	89.4
504	2 mi N of Stanford Point	1.4	*49.6*‡	12.2‡	10.2	0.0	0‡	0.4	0	0.4	0.2	47.8	86.2
505	1 mi SW of Stanford Point	0.8	*47.2*	4.5‡	9.2‡	1.6	0.2‡	*	0	0	0	38.4	47.0
506	1 mi S of Stanford Point	3.0	*50.4*	5.8‡	*44.4*‡	4.0‡	1	*	0	0	0	23.4	67.8
507	1 mi NE of Stanford Point	0	*17.6*	1.6	2.0	0.8	0	0	0	0	0.8	40.6	87.4
508	1 mi W of Stanford Point	6.4	*52.8*‡	*23.4*‡	*27.0*	0‡	0.4	0.2	0	0.2	0	20.6	92.4
509	2 mi NW of Stanford Point	1.6	*45.4*‡	13.8‡	*26.6*‡	0.8‡	1.2‡	0.6	0.2	0.4	0.4	43.2	81.6
510	Moon Hill	12.8	*53.6*‡	*36.0*‡	18.2‡	1.2	0‡	0.2	0	0.2	0.8	35	67.2
511	2 mi SE of Moon Hill	12.0	*47.8*‡	*20.4*‡	*21.0*‡	2.4	0	*	0	0	0.2	13.2	80.4
512	3 mi S of Mineral Mtn	*17.2*	*70.8*‡	5.6‡	9.4	0	0	*	0	0	0.2	70.2	*
513	2 mi SW of Moon Hill	3.4	*55.4*‡	13.0	1.2	0‡	1.4	*	0	0	0	9.6	9.2
514	1.5 mi NW of Avon	2.8	*42.8*	6.2	3.0	0	0	*	0	0	0	6.8	61.4
600	3.4 mi NNW of Princeton	0	*38.8*	4.8	4.0	2	0.25‡	*	*	*	*	*	*
601	Macumber Meadows	0.8	*52.2*	1.6	0.6	0	0‡	*	*	*	*	*	*
602	S of Shay Hill	0.4	*1.4*	0.2	4.4‡	1.2	0.2	*	*	*	*	*	*
603	3 mi. S of Chatcolet	5.0	*101.8*‡	10.8‡	*29.2*‡	3.6	0	*	*	*	*	*	*
701	Fourmile Creek	0.2	*53.0*‡	*28.2*‡	12.2‡	2.2‡	0.4	*	0	0	0	9	88.6
702	North of Granite Point	1.2	*40.8*‡	10.2	3.4	0.6	0	*	0	0.2	0	5.8	76
703	Bergs Creek	0.2	12.4	3.2	2.4	0	0	*	0	0	0	12.2	96.6
704	West Fork Big Bear Creek	0.6	*49.6*	8.8‡	9.4‡	0.8	0‡	0.2	0	0.2	0.2	13.2	61
705	2 Mi NW of Stanford PT	18.2	*53.2*‡	*34.2*‡	*43.0*‡	3.0‡	1.5‡	0.8	0	0.8	0.4	46.4	89.4
706	1 Mi S. of Iron Mtn	0.4	*77.2*‡	*27.8*	2.0	0.2‡	0.8‡	*	0	0	0	27.2	87.8
707	Iron Mtn	*	*	*	*	*	*	*	0	0	0	6.6	97
708	Little Bear Creek	2.2	*46.6*‡	12.4‡	7.3	0‡	0.4‡	*	0	0	0	65.6	108.6
709	Ruby Creek	10.0	*47.2*‡	10.6	2.4‡	4.0	0	*	0	0	0	50.4	96.2
710	Turnbow Creek	*16.2*	*53.8*‡	*33.0*‡	15.8	0‡	2.4‡	1.4	0	1.4	0.2	43	70.6
711	East Fork Flat Creek	12.2	*55.4*‡	*20.8*‡	17.6	0‡	2‡	2.6	0	2.6	0.2	55	71.4
712	Turnbow Point	0.2	*37.4*‡	1.2	0.2	0.4	0.2	*	0	0	0.2	7.8	38
713	3 Mi S. of Potlatch	0.6	*47.8*	13.0‡	8.8‡	5.8	0‡	*	0	0	0	6.6	30
714	Rocky Point	*23.4*	*20.6*‡	*25.6*‡	*46.6*	0.0‡	0.8	*	0	0	0	13.2	79.6
715	Hatter Creek	0	11.6	0.0	0.2	0	0‡	0.6	0	0.6	0.2	7.4	32
716	Head of Hatter Creek	0	*48.2*	0.4	0	0	0	*	0	0	0	11.8	80.8

* Indicates Sites Not Trapped m indicates traps missing ‡ Indicates larval survey *Italics indicates egg mass sample*

Appendix 1. (continued)

IDL 2001 - 2012 Douglas-fir Tussock Moth Trap Results

Mean Number of Moths Per Trap

Plot #	Area	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
717	Nora Creek	0.2	*14.2*	0.2	0.2‡	1.4	0	*	0	0	0	21.2	81.4
718	Crummaring Creek	0	*49.0*‡	13.6‡	6.4	0.4	0.2	*	0	0	0	12.4	70.4
719	Basalt Hill	3.4	*47.2*‡	10.4‡	7.3	1.2	0.2	*	0	0	0	19	11.6
720	Browns Meadow	3.4	*55.8*‡	*30.0*‡	18.2	0‡	0.4	0	0	0	0.2	11.2	2.6
721	Smith Creek	2.2	*46.6*	2.6	0	0.4	0	*	0	0	0	100.2	70.6
722	Prospect Peak	3.6	*47.4*‡	*14.4*	2.8	0.4	0	*	0	0	0	31.2	56.8
723	West Fork Mission Creek	15.4	*50.4*‡	15.8‡	*38.4*	0	0	*	0	0	0	27.8	22.2
724	Huckleberry Mtn	1.4	*75.0*‡	*30.2*‡	14.8	0.2	0‡	*	0	0	0	16.6	77.2
725	North Fork Pine Creek	1.4	*62.4*‡	*43.6*‡	13.6‡	1.2‡	0.75	*	0	0	0	21.6	93
726	Mineral Creek	*25.6*	*65.4*	5.4‡	10.4	0	0	*	0	0	0	20.2	78
727	South of Sanders	29.2	*59.8*	3.6	0.8	0	0	*	0	0	0	77.8	86.8
800	Mason Butte	8.8	*5.4*	13.2‡	*38.2*‡	9.0‡	7.25	*	*	*	0	20.8	63
801	1 mi SW of Moctileme Butte	5.5	*21.4*‡	6.8‡	9.8‡	2.8	0.2	*	*	*	0	30.2	91.4
802	1.9 mi S of Plummer	2.4	*80.0*‡	*40.0*‡	*39.6*‡	1.6	0	*	*	*	0	24.8	75.2
803	Little Plummer Creek	10.6	*115.4*‡	*14.2*‡	*57.0*‡	17.6‡	5.8	*	*	*	0	18	54.4
804	Syringa Creek	0.4	11.0	1.3	0.4	0	0	*	*	*	0	21.2	66.4
805	John Point	*	*	*	*	*	*	*	*	*	0	20.4	61.6
806	2 mi W of Pettis Point	0.8	*36.6*	3.6	0.4	0.2	0	*	*	*	0	22.6	71.2
807	Davis Creek	0.2	*26.4*	3.0	m‡	1.0	0	*	*	*	0	17.8	55.6
808	Renfro Creek	0.0	*37.8*	3.0	0.4	0	0	*	*	*	0	14.8	44.2
809	Crystal Creek	0.4	*9.8*	0.6	0.4	0	0.2	*	*	*	0	10.4	29.4
810	Child Creek	0.8	*25.2*	0.6	0.6	0.2	0	*	*	*	0	17.2	52.8
811	Hobo Pass	2.2	*13.6*	2.5	m‡	2.4‡	0.6	*	*	*	0	7.8	25.4
812	Hemlock Butte	0.2	*37.0*	1.8	0.5	0.2‡	0.4	*	*	*	0	9.2	28.2
813	Carpenter Peak	0.0	*12.6*	3.6	1.6	0	0	*	*	*	0	18.8	57.8
814	Tyson Creek	0.6	*1.4*	1.0	2.8	0	0	*	*	*	0	30.2	87.6
815	Heinaman Creek	0.0	*2.4*	0.6	m	0.6	0	*	*	*	0	25.2	85.2
816	Green Mtn	2.2	*38.4*	4.8‡	5.2	0.4	0	*	*	*	0	31	86.2
817	Willow Creek	2.8	*32.0*	1.4‡	6.2‡	2.6‡	1.2	*	*	*	0	22.2	73.2
818	Head of Emerald Creek	2.0	*46.4*	5.8	3.6	0	0.6	*	*	*	0	28.2	86
819	East Fork Emerald Creek	0.4	*2.6*	1.0	0.2	0	0	*	*	*	0	25	75.2
820	Head of Bobs Creek	0.4	9.8	2.0	0.6	0	0	*	*	*	0	25.4	79
821	East Fork of Potlatch River	0.4	*50.8*	5.0	3.8	0.2	0	*	*	*	0	25.2	67.2
822	Head of Moose Creek	9.2	*45.6*‡	14.8	2.2	0	0.2	*	*	*	0	24.8	69.6
823	Beals Butte	0.4	*58.2*	1.2	2.2	0	0	*	*	*	0	39	106.2
900	Hauser	0.8	6.0	1.8	2.4‡	1.4	*	*	*	*	*	*	*
901	Cougar Bay	0	*29.4*	*6.4*‡	5.2‡	1.4	*	*	*	*	*	*	*
902	Marie Creek	0.3	2.3	2.0	1.2‡	0.8	*	*	*	*	*	*	*
903	Canary Creek	0	12.8	3.8	2.8	0	*	*	*	*	*	*	*
904	Rathdrum	0	23.2‡	17.2	2.6	*	*	*	*	*	*	*	*
905	State Line (Post Falls)	0	6.6	0.6	2.0	*	*	*	*	*	*	*	*
906	Signal Point (Post Falls)	0.4	*3.2*‡	9.4‡	41.8	*	*	*	*	*	*	*	*
907	Blake Draw Creek	11.8	*27.4*‡	6.6‡	7.0	*	*	*	*	*	*	*	*
908	Coon Creek	11.0	*47.4*‡	*33.2*‡	*71.6*	*	*	*	*	*	*	*	*

* Indicates Sites Not Trapped m indicates traps missing ‡ Indicates larval survey *Italics indicates egg mass sample*

Appendix 1. (continued)

IDL 2001 - 2012 Douglas-fir Tussock Moth Trap Results

Mean Number of Moths Per Trap

Plot #	Area	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
909	Heyburn Park	1.6	*56.4*‡	11.4‡	9.6	*	*	*	*	*	*	*	*
910	Coyote Lane Post Falls	0.2	*54.0*‡	18.6‡	*67.6*	*	*	*	*	*	*	*	*
911	State Line (Meredith Rd)	0.4	*58.8*‡	14.4‡	23.2	*	*	*	*	*	*	*	*
912	Lovell Valley Direct Sale	5.6	*65.8*‡	*55.2*‡	*69.6*	*	*	*	*	*	*	*	*
913	Twin Lakes	0.2	*66.8*‡	*35.6*	*	*	*	*	*	*	*	*	*
914	McGovern Tree Farm	0.2	*4.6*	*	*	*	*	*	*	*	*	*	*
915	Signal Point #1	0	*39.4*‡	*	*	*	*	*	*	*	*	*	*
916	Signal Point #2	0	*54.2*‡	*	*	*	*	*	*	*	*	*	*
917	Signal Point #3	0	*22.8*‡	*	*	*	*	*	*	*	*	*	*
918	Signal Point #4	0	*60.0*‡	*	*	*	*	*	*	*	*	*	*
919	Signal Point #5	0	*35.4*‡	*	*	*	*	*	*	*	*	*	*
920	Spirit Lake	0	*10.8*	*	*	*	*	*	*	*	*	*	*
Number of Sites Trapped:		141	141	134	133	124	120	51	98	98	122	122	117
Average Number of Moths per Plot:		**6.3**	**43.8**	**11.8**	**11.9**	**1.1**	**0.4**	**0.3**	**0**	**0.2**	**0.2**	**31.3**	**71.5**

*Indicates Sites Not Trapped

m indicates traps missing

‡ Indicates larval survey

Italics indicates egg mass sample

Appendix 2. Mean trap catch for USFS-R1 monitored plots from Potlatch to Lucille from 2001 - 2012.

USFS R1 2001 - 2010 Douglas-fir Tussock Moth Trap Results

Mean Number of Moths per Trap

Plot #	Site Name	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
1-1	Lodge Pt	0	2.2	0.2	3.0	0.0‡	0.0	0.0	0.0	0.0	0.2	1.2	1.6
1-3	Pine Knob	0	41.8	8.6	16.4	0.0‡	0.2	0.3	0.0	0.0	0.0	1.0	4.8
1-4	Potatoe Hill	0	18.6	0.4	1.4	0.0‡	0.0	0.0	0.0	0.0	0.0	0.2	0.2
1-5	Big Tinker	0	4.6	0.2	0.0	0.0‡	0.0	0.2	0.0	0.0	0.0	0.6	1.4
2-1	Rhett Cr	0	0.2	0.0	0.0	0.33§	0.0	0.0	0.0	0.0	0.0	0.0	0.4
2-2	Christie Cr	0	4.6	1.6	1.4	0.67§	0.0	0.0	0.0	0.0	0.0	0.0	8.0
2-3	Cow Cr Saddle	*	*	*	*	*	*	*	0.0	0.0	0.0	0.2	0.2
2-4	Low Saddle	*	*	*	*	*	0.0	0.4	0.0	0.0	0.0	0.0	0.4
2-5	S. Cow Cr	0	0.2	0.8	1.4	0.0§	0.0	0.0	0.0	0.0	0.0	0.0	1.8
2-6	Spring Mtns	0	0	0.0§	1.4	0.0§	0.0	0.0	*	*	*	*	*
2-7	New Site	0	0.2	0.4	*	*	*	*	*	*	*	*	*
3-1	Keuterville	0	3.8	1.2	0.4	0.0§	0.0	0.0	0.0	0.0	0.0	0.0	2.2
3-2	Cottonwood Butte	0	0.4	0.2	0.4	0.0‡	0.0	0.0	0.0	0.0	0.0	0.0	2.8
4-1	Lake Waha	0	1.6	0.0	0.0	0.0§	0.0	0.0	0.0	0.2	0.0	0.0	10.2
4-2	Black Pine	0	3.4	0.6	4.0	1.25‡	0.2	0.0	0.0	0.0	*	0.2	18.2
4-3	Junction	0	1	0.8	0.8	0.0§	0.0	0.0	0.0	0.0	0.0	0.0	*
4-4	Captain John	0	0.8	0.0	1.0	0.33§	0.0	0.0	0.0	0.0	0.0	0.2	3.6
4-5	Webb Cr	*	*	*	*	*	0.0	0.0	0.0	0.0	0.0	0.0	1.4
4-7	No Name	0	4.6	1.2	9.4	0.0§	*	*	*	*	*	*	*
5-1	Johnson	*	*	*	*	*	*	0.0	0.0	0.0	0.0	4.8	4.0
5-2	Angel Butte	0	0.6	0.2	0.6	0.0	*	0.0	0.0	0.0	0.4	0.8	5.8
5-3	Grangemont	0	9.6	1.2	1.0	0.80	1.4	1.4	0.0	0.0	0.4	2.2	16.2
5-4	Bargamin Ck.	0.2	14	m	2.0	0.60	4.6	0.0	0.0	0.0	0.0	4.8	35.6
5-5	Bald Mtn	0§	10.4	1.2	1.6	0.20	3.4	1.8	0.0	0.0	0.2	9.0	36.0
5-6	Summit Landing	0	0.6	1.2	1.8	1.00	3.2	0.6	0.0	0.0	0.2	0.0	14.6
5-7	Shin Pt	0	3	1.0	0.2	0.25	0.0	0.0	0.0	0.0	0.0	1.3	13.2
5-8	Swanson Ck.	0	2.4	0.8	0.8‡	0.40	0.8	0.6	0.0	0.0	1.4	0.0	17.5
5-10	Cooper	*	*	*	*	*	0.0	0.0	0.0	0.0	0.0	0.2	3.8
5-11	Cook Ck.	0	2.8	2.0‡	3.6	*	*	*	*	*	*	*	*
5-12	Whiskey Ck.	0	3	0.0	1.0	*	*	*	*	*	*	*	*
6-1	Canyon Junction	0	13.2	0.4	1.2	0.25‡	0.4	0.0	0.0	0.0	0.0	0.8	11.2
6-2	Fan saddle	*	*	*	*	*	0.0	0.0	0.0	0.0	0.0	0.2	0.6
6-3	Mud Ck.	0	1	0.8	0.0‡	0.0	*	*	*	*	*	*	*
7-1	Laird Park	*	*	*	*	0.0	0.2	0.0	0.0	0.0	0.0	52.2	*
7-2	Little Bald Mtn.	0.2	61.6	1.4	3.6	*	0.0	0.0	0.0	0.0	0.2	22.0	*
7-3	Little Boulder Ck..	0.2	7.8	2.2	1.0	0.20	0.0	1.2	0.0	0.0	4.0	40.4	*
7-4	W. Fork Potlatch R.	0.2	8.6	2.0	1.2	0.80	0.0	0.8	0.6	0.0	2.4	40.4	*
7-5	Elk Creek Falls	0.2	0	1.8	2.0	0.80	0.2	0.4	0.4	0.0	4.8	15.8	*
7-6	Morris Creek	2.0	16.8	m	1.4	0.75	0.0	0.2	0.0	0.0	0.2	26.5	*
8-1	Rose Creek	2.3§	*	*	*	*	*	*	*	*	*	*	*
8-2	Wise Lane	1.6	*	*	*	*	*	*	*	*	*	*	*
8-3	Old Tensed Lane	1.4	*	*	*	*	*	*	*	*	*	*	*
	Number of Sites Trapped:	35	32	32	31	29	31	33	33	33	32	33	26
	Mean Number of Moths per Site:	0.2	7.61	1.08	2.06	0.30	0.47	0.24	0.03	0.01	0.45	6.82	8.30

* Indicates Sites Not Trapped

§ Indicates 3 traps/site

m indicates missing traps

‡ Indicates 4 traps/site

Appendix 3. Mean trap catch for USFS-R4 monitored plots in southern Idaho for the last five years.

USFS R4 2008 Douglas-fir Tussock Moth Trap Results

	Site	2012	2011	2010	2009	2008
1	South Fork Boulder Creek	0.5	0.4	0	0.2	0.2
2	Mill Creek	1	0	0.2	0.2	0.2
3	New York Summit	1.2	0.6	0	1.6	1.2
4	Baldy Mt.	*	0	0.2	0.8	1
5	Upper Wolftone Creek	*	1.2	0	0.8	1.4
6	Brundage Mt Resort	0	5.4	0.2	1.6	1
7	Bogus Basin Resort	0.6	0.4	0.2	15.2	15.4
8	Sharps Canyon	2.2	1.8	*	*	*
9	Lower Scriver Cr	1.4	5.8	*	*	*
10	Paradise Springs	0.2	0.4	*	*	*
11	Lost Man	*	2.4	*	*	*
12	Couch Summit	0	0	*	*	*
	Number of Sites Trapped:	9	11	7	7	7
	Mean Number of Moths per Site:	0.79	1.53	0.16	2.91	2.91

Appendix 4. Viral-caused mortality of Douglas-fir tussock moth larvae reared from egg masses collected at 23 individual sites in Idaho and Washington

Collection Location	Virus Present	% Larval Mortality** Total	Virus
Agency Rd T46N R5W S22-1	+++	58	13
Coon Ck #908 T46N R4W S27	+++	34	15
Coon Ck #201 T46N R3W S30	+++	29	8
Fairfield Rd. T46N R5W S10		31	0
Hwy 95 County Line T46N R4W S6	+++	61	27
King Valley T44N R5W S35		16	0
Lovell Valley #912 T46N R5W S36		41	0
Lovell Valley #2 T46N R5W S25	+++	42	12
Mason Butte #800 T47N R4W S29	+++	69	25
McCroskey Park Fireplace #217 T43 R5W S12	+++	24	7
McCroskey Park Min Mt. #11 T43N R4W S20	+++	37	5
McCroskey Park #117 T43N R5W S15	+++	30	7
Mica Top 2 Spokane, WA T24N R45E S23		47	0
Mica Top 1 Spokane, WA T24 R45E S23	+++	43	3
1 mi NW Moses Mt.T44N R4W S24	+++	27	5
Plummer Butte, Morris Property T46N R4W S20-1	+++	59	26
SE Moon Hill Trap Site #511	+++	21	9
T46N R4W S14	+++	37	5
T44N R4W S3	+++	40	18
Tekoa Mt. East Spokane, WA T21N R45E S26		17	0
Tekoa Mt. North Spokane, WA T21N R45E S13		35	0
Windfall Pass #102 T45N R4W S16	+++	70	45
Windfall Pass Ridge T45N R4W S10	+++	46	19

**Overall mortality estimates may be slightly higher than would have been observed for the entire egg mass because caterpillars that were placed on the synthetic diet were from the initial clutch of hatching eggs. Later-hatching eggs were not transferred to the same diet to insure that caterpillars were as close as possible to being in the same development stage following hatch.

Appendices 4 & 5 were excerpted from final a report by Dr. Stephen Cook, Professor at the University of Idaho.

Appendix 5. Parasitoids reared from Douglas-fir tussock moth egg masses collected at 23 individual sites in Idaho and Washington

Collection Location	% Egg masses Parasitized	Parasitoids per Egg mass	Parasitoid species**		
			Tm	Tc	Tsp.
Agency Rd T46N R5W S22-1	88	15.3	++	++	
Coon Ck #908 T46N R4W S27	40	7.4	++	++	
Coon Ck #201 T46N R3W S30	30	5.8		++	
Fairfield Rd. T46N R5W S10	80	16.3	++	++	
Hwy 95 County Line T46N R4W S6	90	16.8	++	++	
King Valley T44N R5W S35	60	12.4		++	
Lovell Valley #912 T46N R5W S36	0	0.0			
Lovell Valley #2 T46N R5W S25	100	16.9	++	++	
Mason Butte #800 T47N R4W S29	70	6.6	++	++	
McCroskey Park Fireplace #217 T43 R5W S12	60	5.4		++	
McCroskey Park Min Mt. #11 T43N R4W S20	30	5.4	++	++	
McCroskey Park #117 T43N R5W S15	40	9.4		++	
Mica Top 2 Spokane, WA T24N R45E S23	100	11.6		++	++
Mica Top 1 Spokane, WA T24 R45E S23	80	15.4	++		
1 mi NW Moses Mtn. T44N R4W S24	40	6.5	++	++	
Plummer Butte, Morris Property T46N R4W S20-1	90	11.4	++	++	
SE Moon Hill Trap Site #511	30	4.1		++	
Stan Smith's CDA Res. T46N R4W S14	80	16.0	++	++	
T44N R4W S3	0	0.0			
Tekoa Mt. East Spokane, WA T21N R45E S26	100	2.3		++	
Tekoa Mt. North Spokane, WA T21N R45E S13	75	8.3	++		
Windfall Pass #102 T45N R4W S16	40	7.5	++		
Windfall Pass Ridge T45N R4W S10	90	18.9	++	++	

** Preliminary identification of parasitoid species reared from egg masses were:
Tm = *Trichogramma minutum* (Hymenoptera: Chalcidoidea: Trichogrammatidae)
Tc = *Telenomus californicus* (Hymenoptera: Serphoidea: Scelionidae)
Tsp. = *Tetrastichus* sp. (Hymenoptera: Chalcidoidea: Eulophidae)

Appendices 4 & 5 were excerpted from a final report by Dr. Stephen Cook, Professor at the University of Idaho.